Space Weather Technical Forecast

Issued on Tuesday, 28 February 2023 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor Storms possible 28 Feb. Chance of M-flares, with slight chance of X-flares, primarily from AR3234.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low, with several low energy C-class flares. There are seven sunspots on the visible disc, six numbered and one unnumbered region on the northeast limb. The largest region, AR3234, in the northwest quadrant is significantly complex and contains a delta spot. The region on the northeast limb could also reveal further complexity as it rotates further into view. No Earth-directed CMEs have been observed on available imagery.

S**olar Wind / Geomagnetic Activity:** Solar winds were initially strong or very strong due to the effects of two CME arrivals, starting the period at around 800km/s. As the CME effects waned, the speed has fallen to 600km/s, which is probably due to a high speed stream from coronal hole 79, which was initially masked by the CME effects. Density was around or below average. Total magnetic field strength started at around 15nT due to the CMEs, but quickly fell to average around 10nT. The north-south component, Bz started moderately negative, but rotated into a mainly slightly positive or near neutral orientation from around 28/0400UTC. Phi angle started indeterminate, but mainly positive (away from the Sun), then became persistently negative from around 27/2100UTC. Geomagnetic activity started at G2/Moderate Storm levels falling to G1/Minor Storm for one intervals, but has been Quiet since. 28/0600UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has been steadily retreating to background levels through the last 24 hours. Electron flux started at mainly background, but has been increasing towards the high (1e3pfu) threshold, reaching 7.36e3pfu at 28/0445UTC. Electron fluence has started to increase, reaching 2.38e6 integrated pfu at 28/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Low to Moderate activity is forecast through the period, mainly due to the large, complex region AR3234 in the northwest quadrant. An emerging region in the far northeast may also start to contribute to the flare risk.

Solar Wind / Geomagnetic Activity: Recent CME activity is declining, with speeds decreasing towards the background high speed stream speed of 500-600km/s. No further CMEs are forecast to affect the Earth. Solar winds are expected to slowly decline towards 300-400km/s by the end of 01 Mar as the high speed stream declines. Geomagnetic activity is forecast to start mainly Quiet to Unsettled, but with an initial small chance of Active to G1/Minor Storm intervals. Mainly Quiet for the remainder of the period.

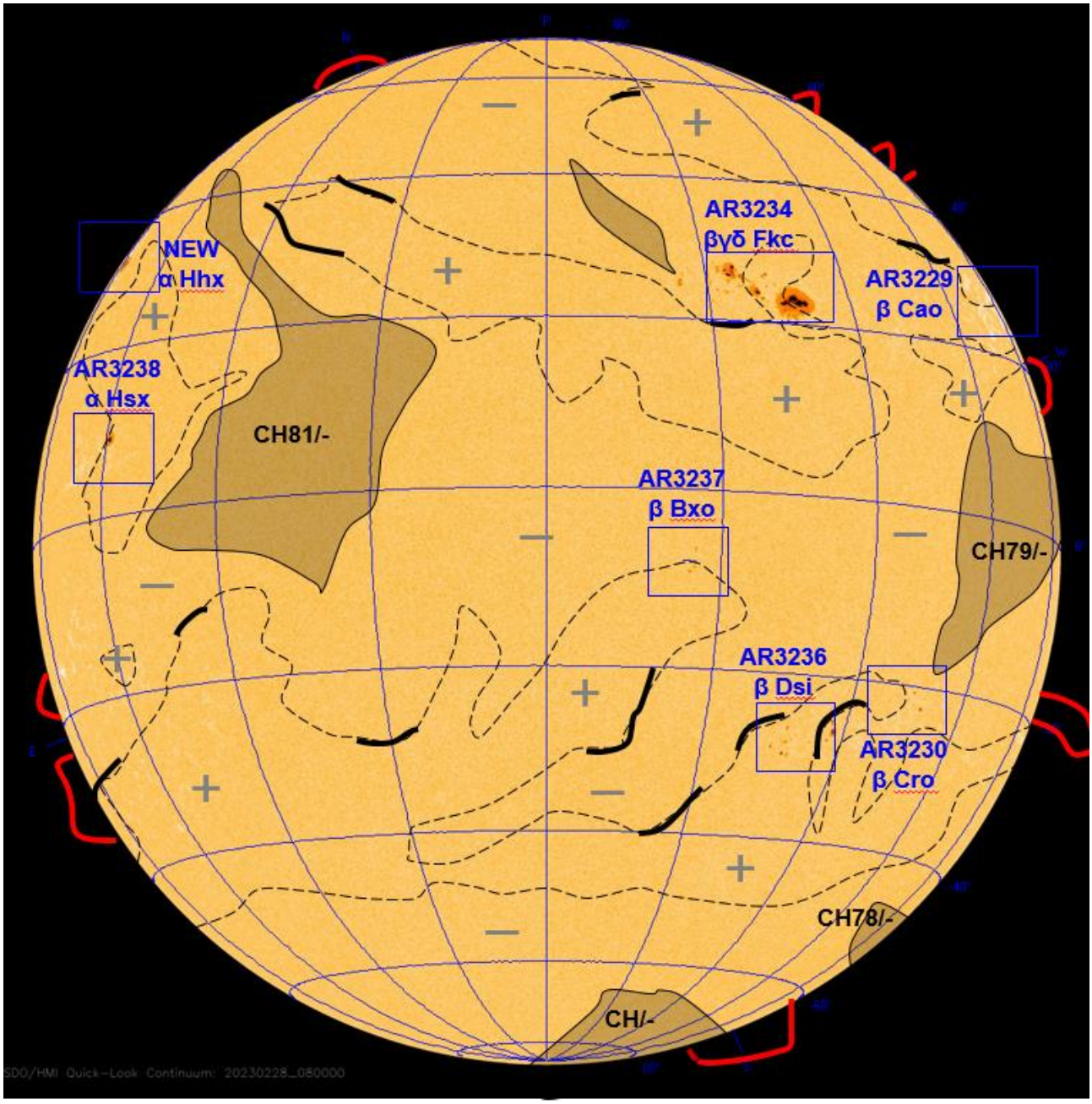
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Met Office Space Weather Technical Forecast

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 2MeV) is below the S1/Minor storm level with only a slight chance of rising above due to any significant flares that occur, primarily from AR3234 in the northwest. High energy electron flux (greater than 2MeV) is expected to rise through the period, increasingly and more persistently exceeding the high threshold on diurnal maximums. Electron fluence is expected to increase with a rising chance of exceeding the Active (1e8 integrated pfu) through the period.

Figure 1. Solar Analysis Valid 28/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

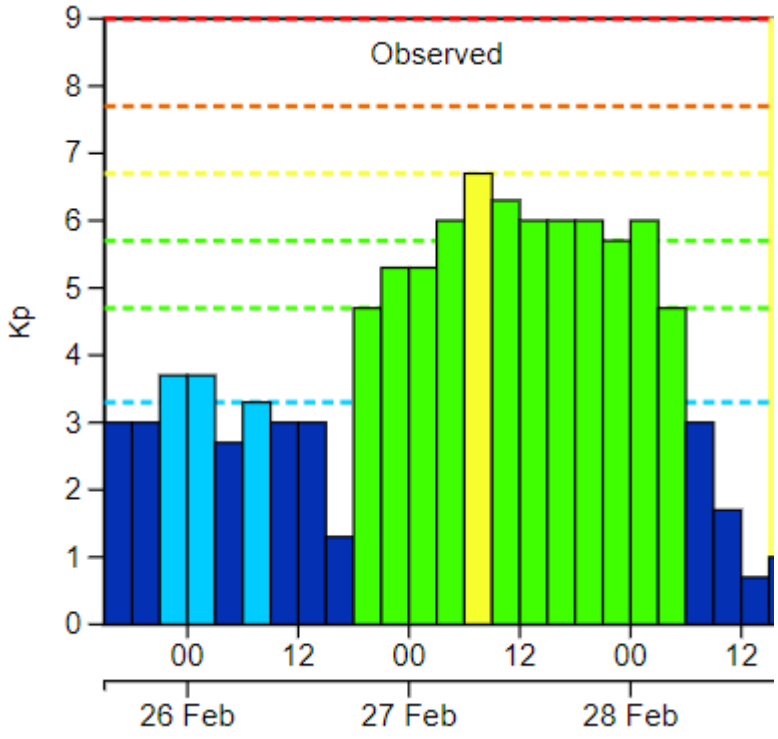
Geomagnetic Storms:

No further CMEs are forecast to arrive at Earth during the forecast period.
The high speed stream from coronal hole 79 is currently connected to Earth, giving speeds of around 600km/s. This is expected to remain connected to Earth through the next two days, with speeds gradually decreasing to background. A coronal hole in the north centre of the Sun may have been modelled by Enlil as affecting the earth, but this appears unlikely to have significant effects, as the Earth is currently below the solar equator, with this hole well to the north. No further coronal holes are expected within the forecast period.

Geomagnetic activity is expected to be mainly Quiet to Unsettled on 28 Feb, with a reducing risk of G1/Minor Storms. Then mainly Quiet to Unsettled through the rest of the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	30	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: BGS observed geomagnetic activity for the last 24 hours.



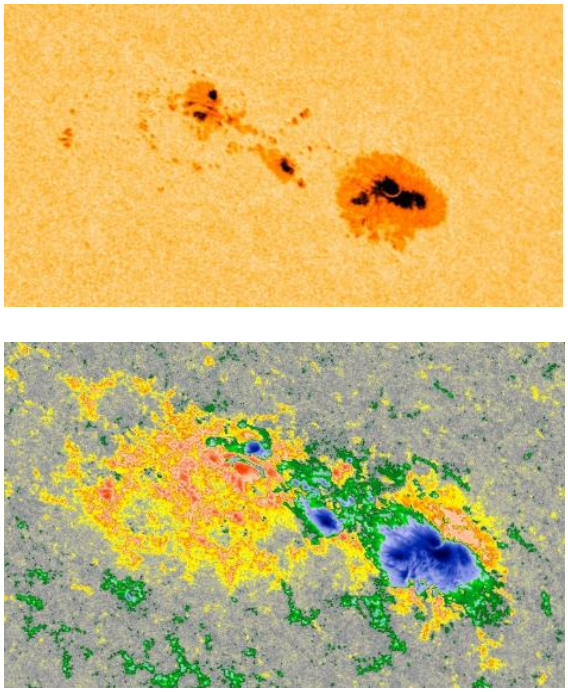
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
There are seven active regions on the visible disc, with the risk of Moderate or Strong activity heavily biased towards AR3234 (Fkc/βγδ) in the northwest quadrant. This is a large region, with significant complexity, especially in the trailer region which contains a contorted delta spot. Although this region has been relatively inactive, it presents a significant flare risk. The remaining numbered regions all appear benign or are fading, including AR3229 (Cao/β) close to the northwest limb, which is increasingly difficult to analyse due to foreshortening.
A new, currently unnumbered region on the northeast limb is continuing to reveal increasing complexity, and is associated with an area of bright flux, which could result in significant flare activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	50	50
Very Active	R3 to R5 X Class	No	20	20	15	10

Figure 3: AR3234 in both HMI intensitygram and magnetogram imagery showing the complexity of the region.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16 has been declining through 27 Feb, and is expected to gradually fall towards background. AR3234 in the northwest quadrant has the potential to produce further significant flaring. This, alongside any other lower risk flare activity from the other regions on the disc brings slight chance of flux rates climbing again and reaching the S1 Minor Radiation storm threshold, especially as the large complex region is in a prime location for Earth-directed solar storms.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The recent CMEs and high speed stream are likely to have loaded the radiation belts with electrons. Initially these will have been displaced from the GEO orbit by the strong solar wind and increased geomagnetic activity. As the speed and activity eases, the electron flux is likely to increase sharply to above the high threshold. The high energy electron flux (greater than 2MeV) is expected to start at mainly moderate to high levels through the next four days, but reaching persistently high levels on diurnal maximum later in the period

Electron fluence values are forecast to reflect this increase with a likelihood of exceeding the active (1e8 integrated pfu) later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	30	60	60	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	5	10	10

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.